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# Overview of Planetary Protection Approach for Europa Clipper Mission

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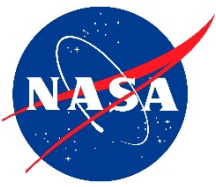
PP.2, Lecture Room SR 02

July 16, 2018

17:15 – 17:30

Brian Cooke, John Day, Emily Seto, Zachary Dean, Laura Newlin, Hyung "Roy" Park

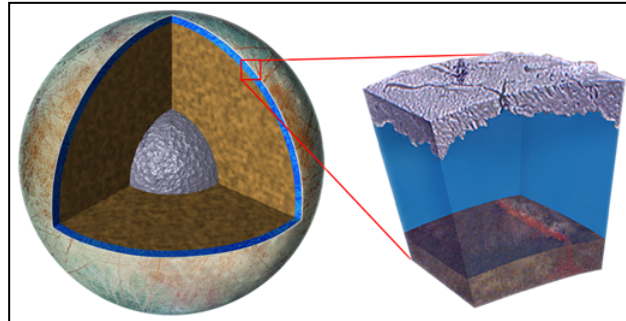
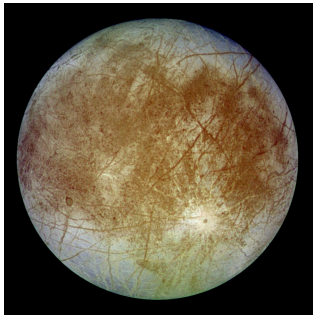
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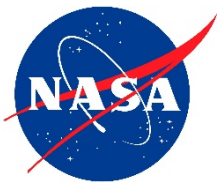


# Europa Clipper Project Science Overview



- Europa Clipper Mission will be the first mission to explore, in depth, this world of rock, ice, and water about the size of Earth's moon for its habitability with the following objectives:
  - **Ice Shell & Ocean** - Characterize the ice shell and any subsurface water, including their heterogeneity, ocean properties, and the nature of surface-ice-ocean exchange
  - **Composition** - Understand the habitability of Europa's ocean through composition and chemistry
  - **Geology** - Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities
  - **Current Activity** - Search for and characterize any current activity, notably plumes and thermal anomalies



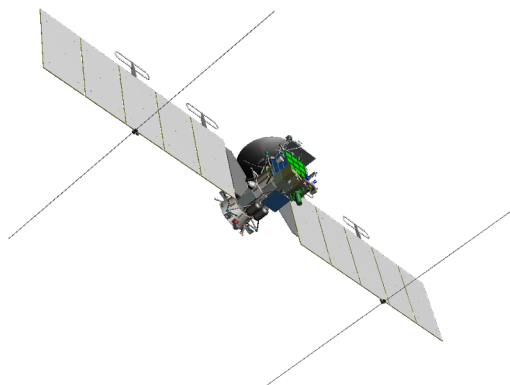


# Overview of Mission and Spacecraft

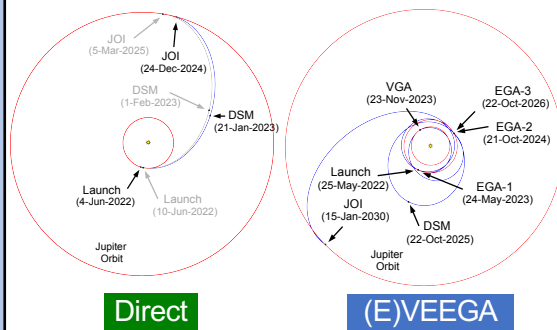


Deploy a resilient spacecraft equipped with a capable payload into Jovian orbit to perform observations of Europa, returning sufficient data to Earth to achieve scientific objectives within mission constraints.

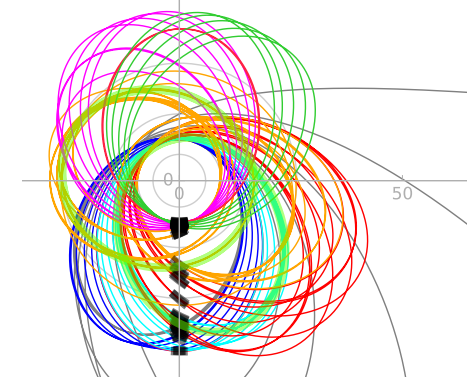
Flight System



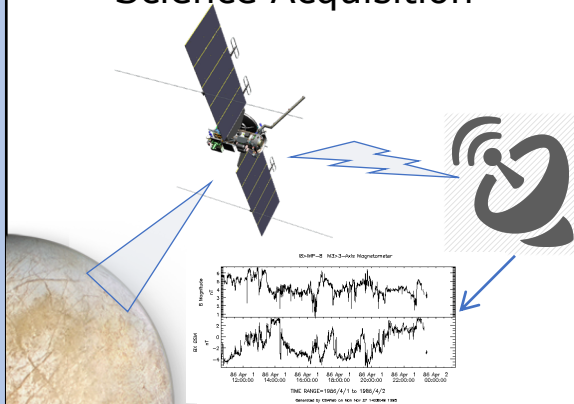
Launch Vehicle and Interplanetary Trajectory



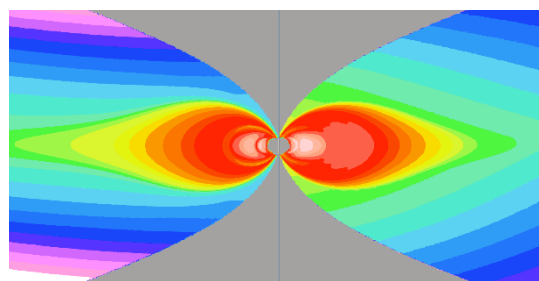
Jupiter Tour



Science Acquisition



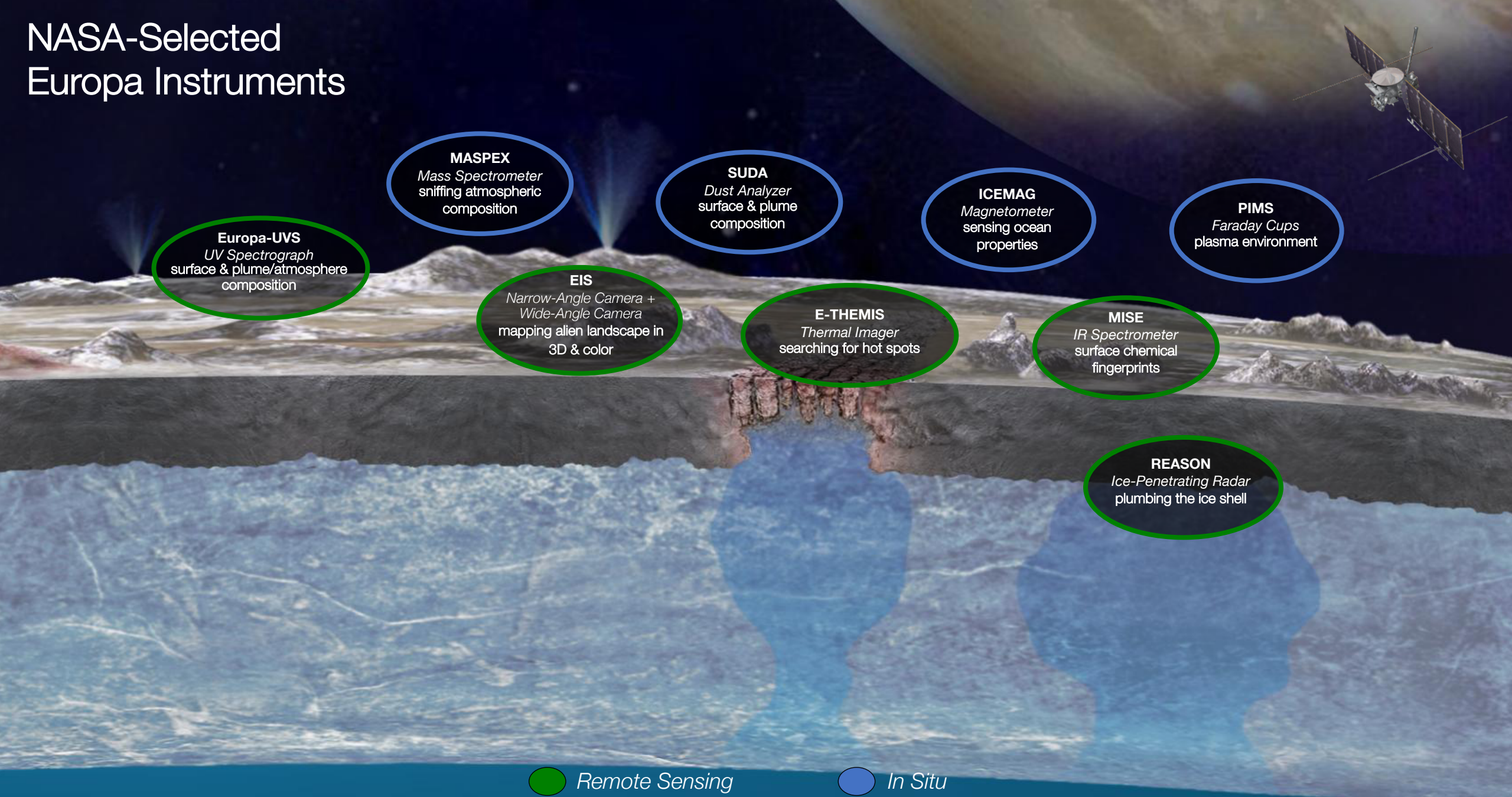
Environmental Tolerance

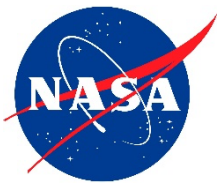


Mission Operations System

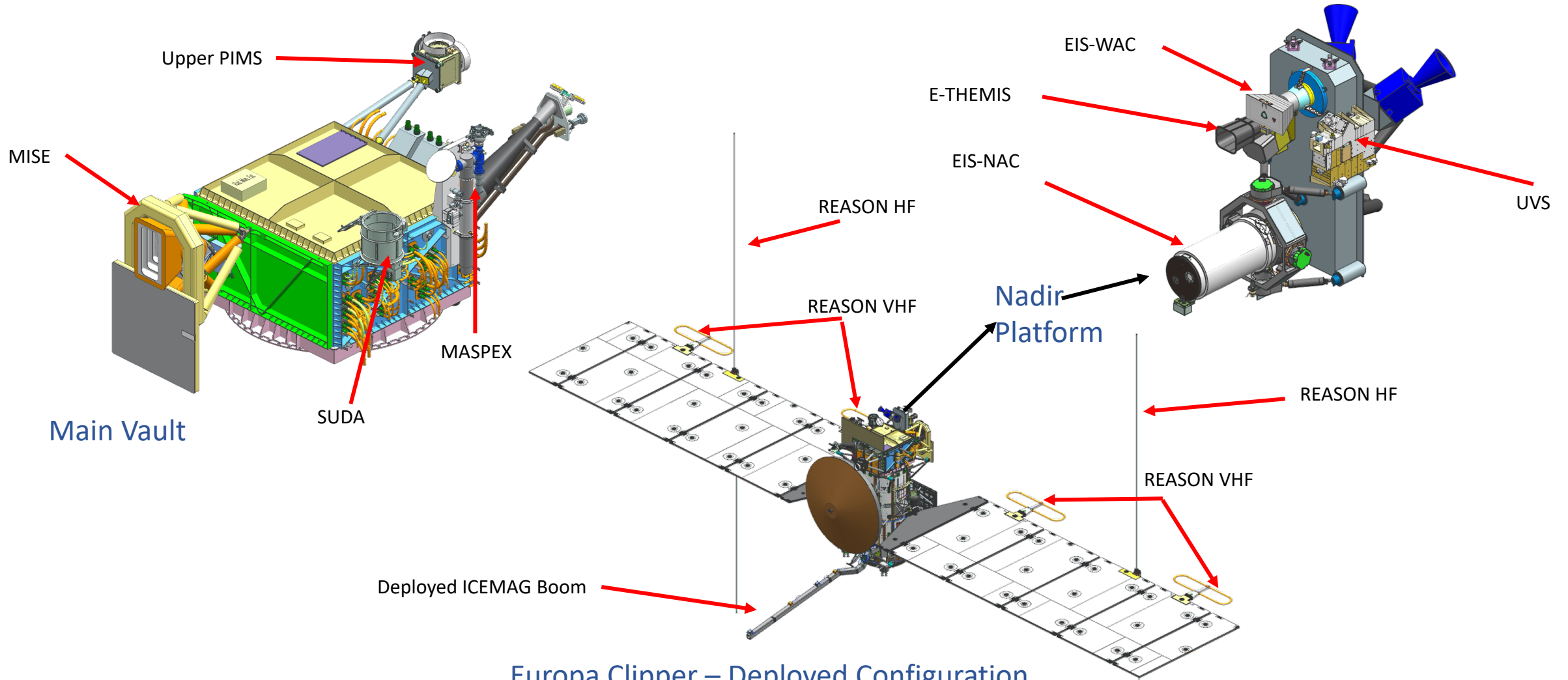


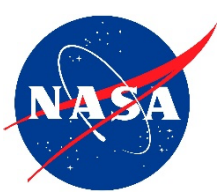
# NASA-Selected Europa Instruments



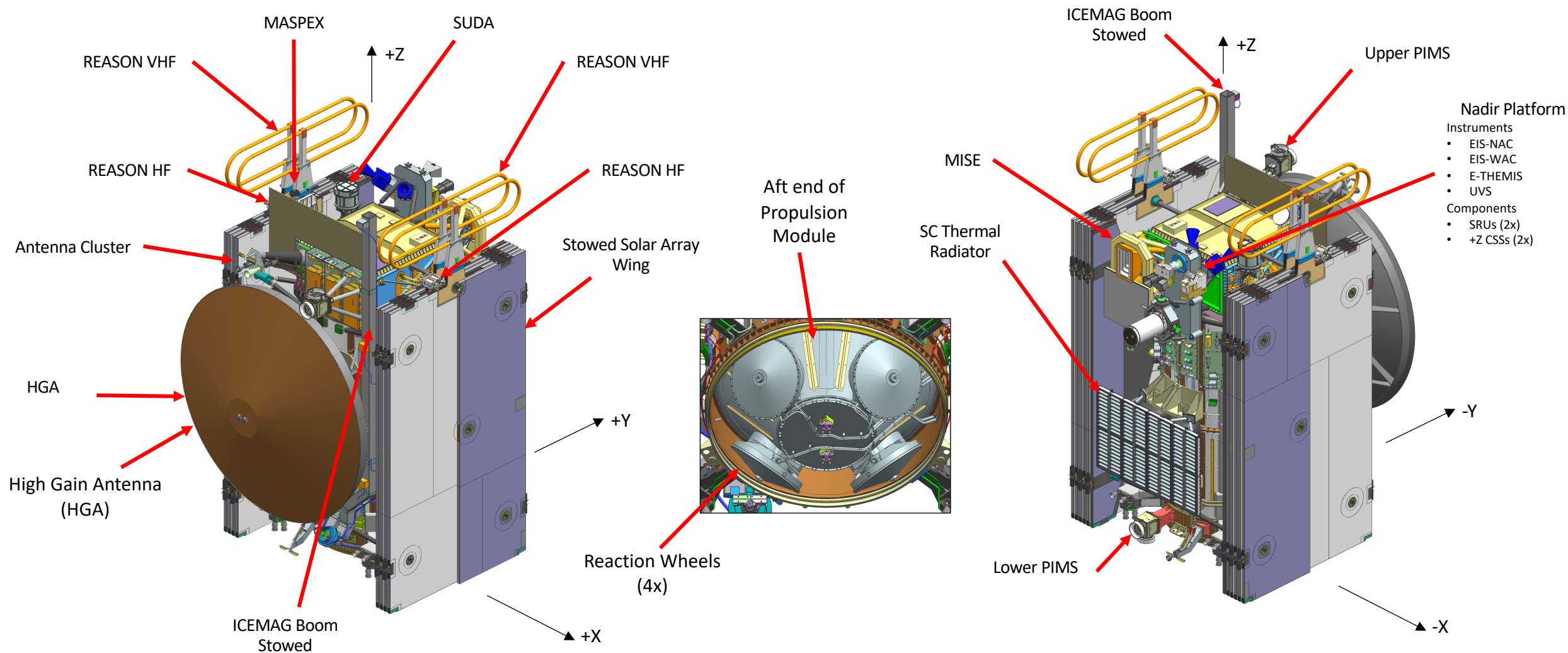


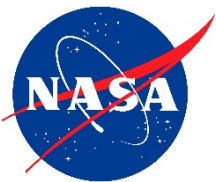
# Europa Clipper Spacecraft Overview (1 of 2)



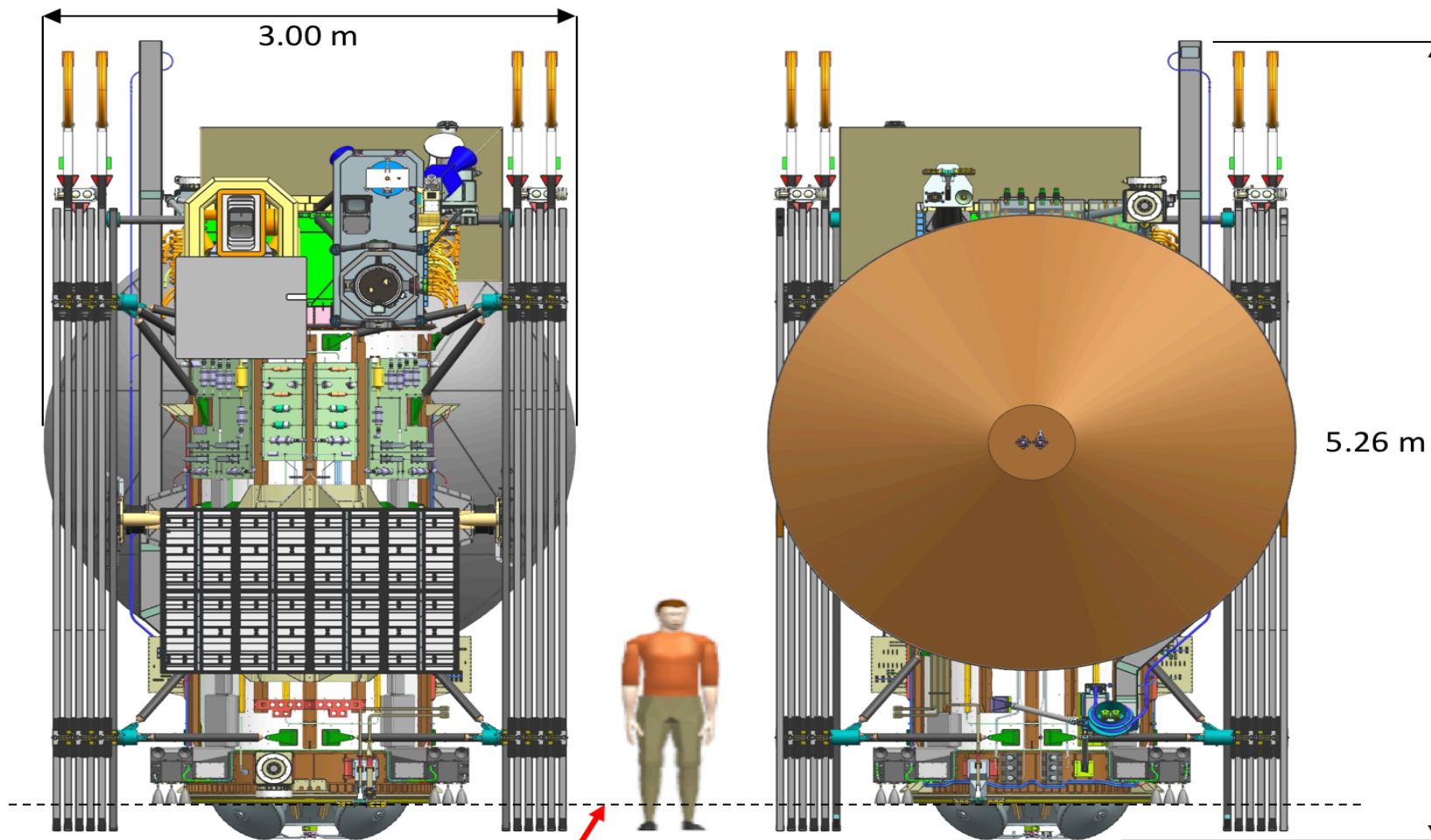


# Europa Clipper Spacecraft Overview (2 of 2)

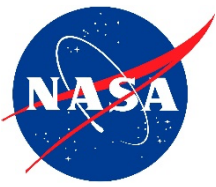




# Europa Clipper Spacecraft Size Reference



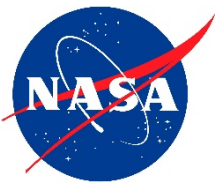
Flight System (FS) / Launch Vehicle (LV) Separation Plane



# Planetary Protection Categorization & Approach



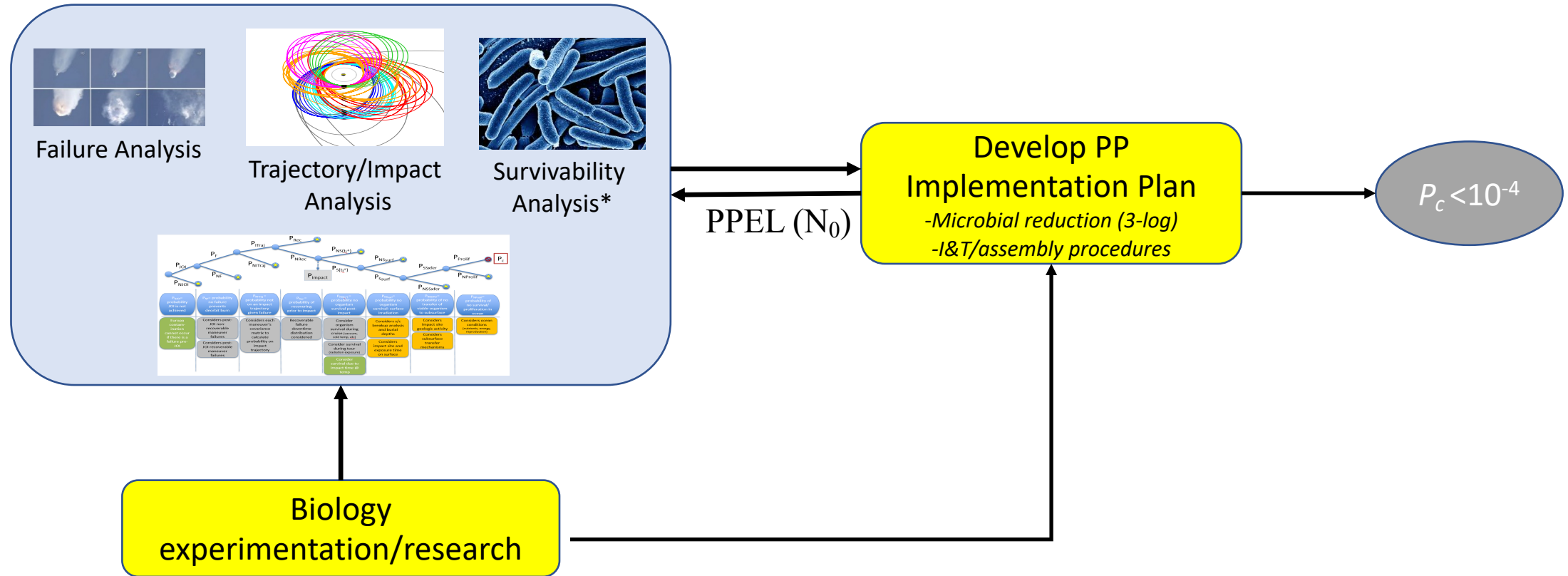
- **Per NPR 8020.12D the Europa Clipper mission is a Planetary Protection Category III**
  - To reduce the probability of inadvertent contamination of an ocean or other liquid water body to less than  $1 \times 10^{-4}$  per mission
- **Europa Clipper Baseline Approach**
  - 3 log microbial reduction of both surfaces and encapsulated volumes – Heat Microbial Reduction
  - ISO 7/Class 10,000 environment for assembly of critical components and during SI&T
  - Recontamination control of SI&T
  - Bioassay sampling spacecraft and components
  - Focus on limiting recontamination of internal spacecraft surfaces
  - Probability Model Team has assessed lethality events from cruise thru the tour to the impact heating event
    - Lethality Factors Assessed - Tour radiation, space vacuum & cold temperatures during cruise, & impact heating
    - Work to go - Analysis of surface irradiation and probability of reaching sub-surface ocean will be quantified



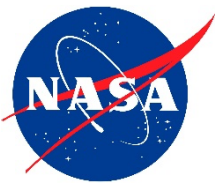
# Europa Clipper Model Status



Build mathematical framework to calculate  $P_c$



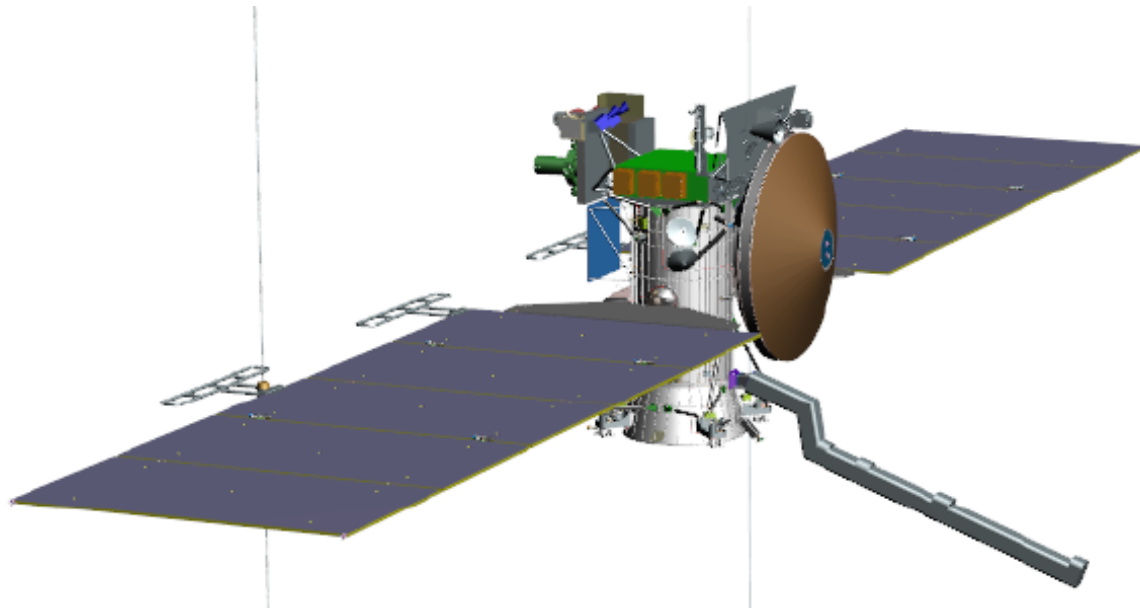
\*Refer to Kelli McCoy's poster board on Europa Clipper Probability Model for more detail

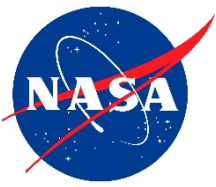


# Bio-region Definition (1 of 2)



- Spatial region of the spacecraft where organisms respond in a similar manner to factors affecting their viability.
  - A bio-region is not necessarily a contiguous region
  - Bio-regions are disjointed from one another (they do not overlap)
  - Within a bio-region, bioburden may either be in an encapsulated, mated, or an external surface of a component

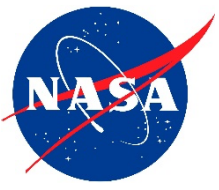




# Bio-region Definition (2 of 2)



- Bio-regions help provide the survivability of organisms across the Europa Clipper Orbiter to determine the probability of contamination
  - Bio-regions provide a higher fidelity to the bioburden at launch
- Bio-regions allow Planetary Protection Engineers the ability to better quantitatively discern contamination risk on the orbiter
- Bio-regions are described by 5 letters with the following categories:
  - Amount of Radiation received
  - Cold/Temperature within region
  - Water Activity within region
  - Exposure to Space Vacuum
  - Impact Heating amount within region

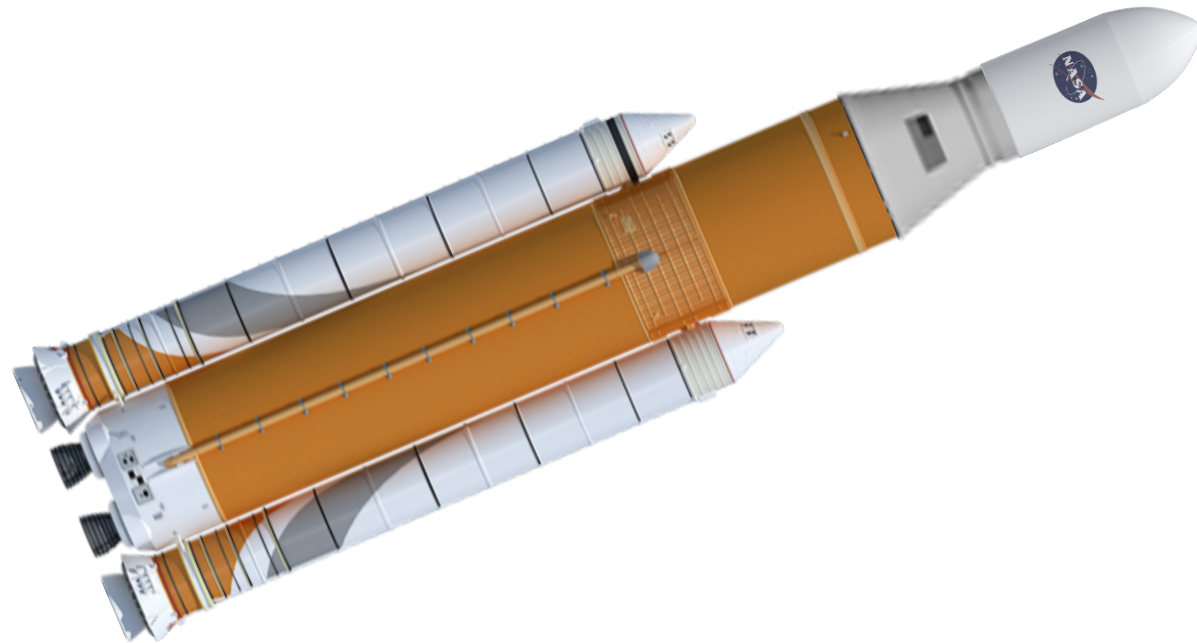


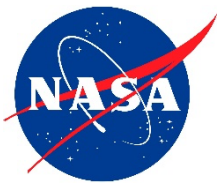
# Europa Clipper Launch Vehicle Overview



- Europa Clipper has baselined SLS Block 1 Cargo Configuration

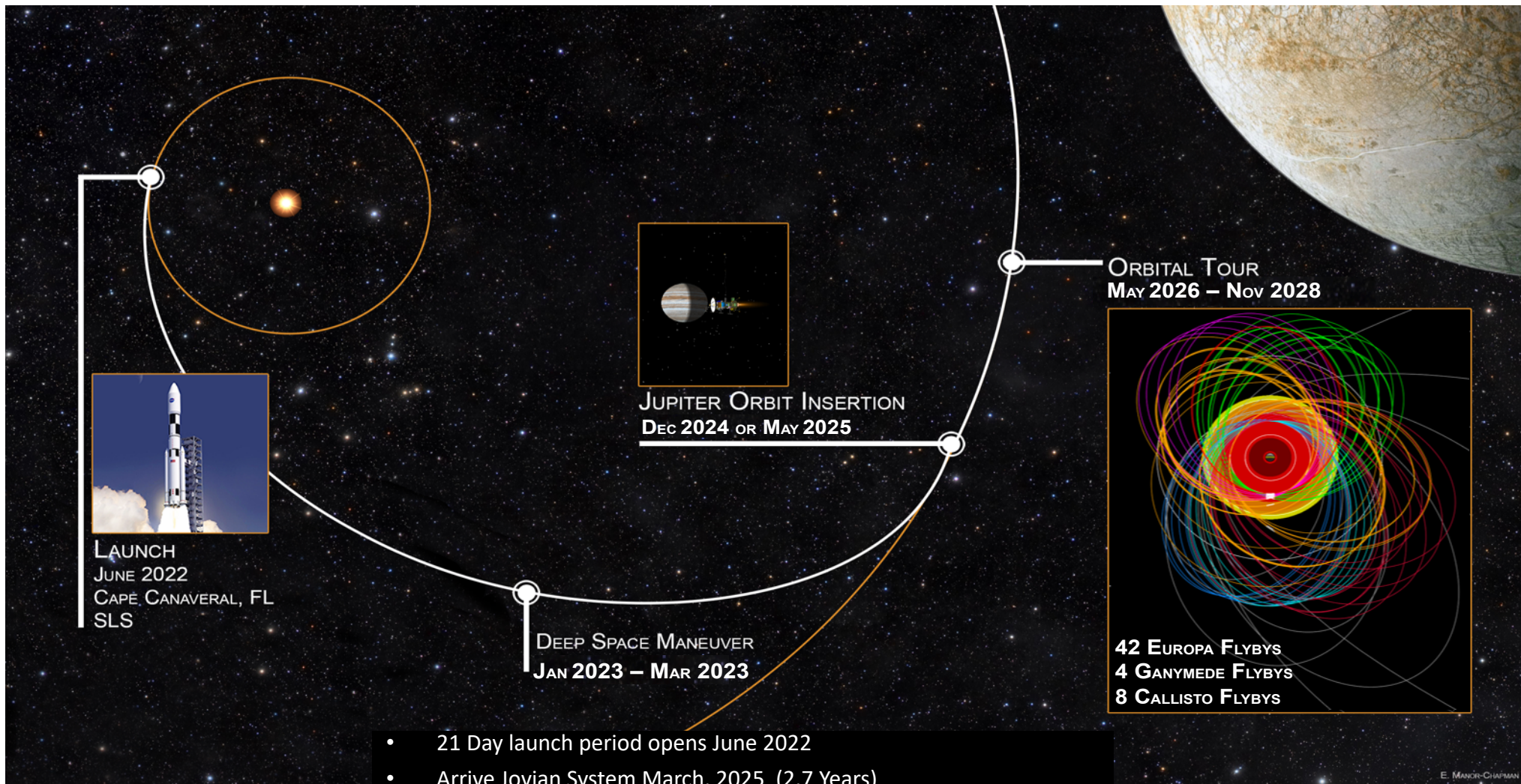
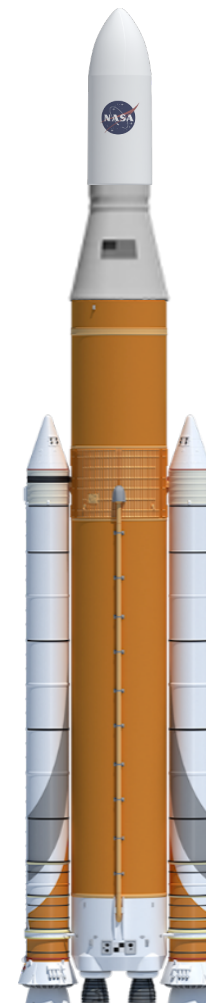
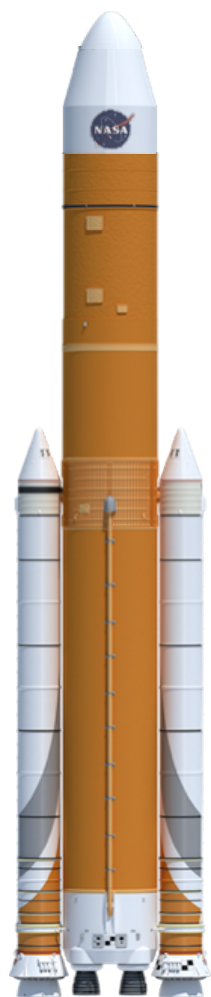
SLS Block 1



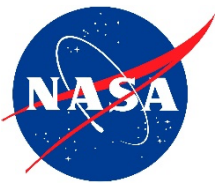


# Direct to Jupiter Trajectory

SLS Launch Option



- 21 Day launch period opens June 2022
- Arrive Jovian System March, 2025 (2.7 Years)



# Europa Clipper Project Status



- Completed
  - Formal Categorization Letter for Europa Clipper
  - Planetary Protection Plan and Approach reviewed by NASA
- Upcoming Review
  - Europa Clipper Project Design Review is in August of 2018
- Future Planetary Protection Work
  - Europa Clipper is now moving into implementation of the Planetary Protection Plan